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(57) Abstract :

The present invention relates to a digital twin system designed for real-time carbon footprint monitoring and optimization in manufacturing. By integrating sensors, IoT devices, and advanced analytics, the system creates a dynamic virtual replica of manufacturing operations, enabling continuous tracking of carbon emissions, energy consumption, and resource usage. The platform employs machine learning algorithms to identify inefficiencies, predict emission trends, and recommend corrective actions. A key feature is the what-if scenario simulation, allowing users to test potential strategies for emissions reduction before implementation. The system also includes automated adaptive control to optimize machine operations and energy distribution in real-time, ensuring sustainability. Additionally, it provides regulatory compliance reporting and integrates seamlessly with existing manufacturing systems. Overall, the invention empowers manufacturers to reduce environmental impact while maintaining operational efficiency, supporting sustainable production in line with global environmental standards.

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